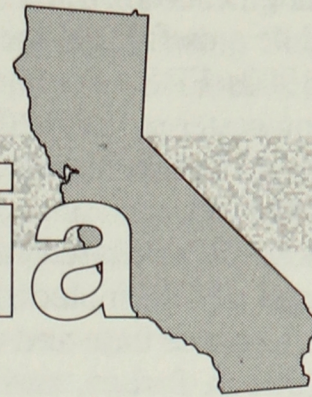# California

A Geographic Information Task Force was created by the legislature in 1991. Since 1989, GIS coordination activities in California have been conducted by the Teale Data Center, which is one of the two mainframe computing centers in California state government. Teale's GIS Laboratory, established in 1988, serves three purposes, including: 1) being a service bureau on a cost recovery basis similar to other computing services at Teale; 2) developing and maintaining a geographic digital data library; and 3) fostering related interagency coordination. Its function includes leading informal coordination groups, such as the Computer Mapping Coordinating Committee (CMCC) formed in 1986, and Teale's GIS Users Group. Another agency involved in GIS work is the California State Mapping Advisory Committee, which is managed by the Department of Water Resources. Recently the coordination groups have been working together to compile digital geographic information, and attempts are now being made to establish a policy-level coordinating group.

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Origins of State Initiatives

Geographic, natural resources and environmental information coordination efforts in California began in the mid-1970s, followed by GIS and other related automated mapping applications. Since 1976, mapping activities have been coordinated by the California State Mapping Advisory Committee (CSMAC). The California State Legislature directed the Department of Water Resources to "collect information relative to maps and surveys of the State of California or parts thereof and provide a public information service for public and private persons and agencies relative to maps and surveys of the State." DWR's Map Information office was designed to meet this need. CSMAC, chaired by DWR, provides input to the U.S. Geological Survey (USGS) regarding mapping priorities.

GIS activities in state government began in the late 1970s when the Department of Conservation initiated the Farmland Mapping and Monitoring Program (FMMP) in response to the need to have more detailed data on farmland, grazing land, and urban buildup areas. Since 1975, efforts had been underway to address farmland conversion, and a 1982 bill proposed a non-regulatory program that could provide information, maps and conversion statistics. FMMP was then empowered to provide maps and data to counties.

The Forest and Rangeland Resources Assessment and Policy Act was adopted in 1977. This legislation requires periodic assessment of conditions and trends for California forest and rangelands, including an evaluation of governmental programs and alternative policy approaches. Beginning in late 1979, the California Department of Forestry's (CDF) Forest and Rangeland Resources Assessment Program (FRRAP) developed a statewide vegetation classification program using LANDSAT imagery. The project was funded through a cost-share agreement with the National Aeronautics and Space Administration (NASA).

CDF conducted some initial work with ESRI's early PIOS software for reforestation and fuel

loading modeling. This effort led to the conclusion that GIS could be a useful tool for the department. In the early 1980s FRRAP conducted in-house GIS work using raster software (SPANMAP) on the University of California at Berkeley's IBM mainframe computer.

In 1986, FRRAP purchased ARC/INFO software. Initial uses of GIS included descriptions of the California resource base and derivation of input data for timber, forage, and wildlife habitat modeling. A central component of the FRRAP Information and Analysis System is the CAL-PLAN simulation model, which was developed to forecast probable changes in resource productivity for use in statewide assessments. GIS was used to contribute statistical data, maps and analyses contained in FRRAP reports, including its *California's Forests and Rangelands: Growing Conflicts Over Changing Uses*.

The California Department of Conservation tracks farmland conversion and urbanization in the state. CDC established the Farmland Mapping and Monitoring Program in the late 1970s to provide data on the nature, location and extent of farmland, grazing land, and urban buildup areas.

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In the mid-1970s the state's Environmental Data Center (EDC) was established in the Governor's Office of Planning and Research. One major effort made by EDC was the coordination of electronic mapping among state agencies. California's Interagency Advisory Committee on Computer Mapping was formed in 1979 as a result of this effort; it existed until the early 1980s. Besides the Energy Commission, the wide range of California agencies which were involved in the electronic mapping project included the following departments: Forestry, Parks and Recreation, Fish and Game, Water Resources, Conservation, Air Resources Board, Coastal Commission, Solid Waste Management Board, Transportation, and Food and Agriculture. The committee concentrated on database development issues and also considered the need of guidelines for digitizing data.

In addition to the activities described above, in 1981 the Resources Agency that incorporates many of the departments discussed, proposed that a comprehensive natural resources database be established and maintained by a coordinating committee. This committee met occasionally and helped to facilitate the Department of Conservation's

attempts to develop the California Automated Resource Inventory (CARI). As part of this effort a statewide survey concerning geographic data was conducted; however, efforts to build the comprehensive database were unsuccessful.

Coordination work in the early 1980s included attempts to establish a State Cartographer position which would be funded by USGS. Discussions of this matter were based in CSMAC, and they included an evaluation of the proper institutional location for the position. Agreement was however not reached about the best organizational location of coordination functions or about the State Cartographer position. Until the early 1980s, California had cooperative agreements with USGS to conduct base mapping, but the state legislature eliminated the cost-sharing activities in or about 1982. USGS was willing to help fund the cartographer, but the position was still not established, and cooperative efforts eventually ceased with USGS.

The Department of Finance's Office of Information Technology (OIT) was created by the California Legislature in 1983. OIT is authorized to approve agency plans related to information technology implementation. In 1986 OIT began receiving requests from various departments for GIS. Accordingly, OIT and the Resources Agency encouraged these departments to coordinate their efforts. With this incentive, the California Computer Mapping Coordinating Committee (CMCC) was created. Original participants included the following departments: Conservation, Forestry, Fish and Game, Water Resources, Agriculture, and Parks and Recreation. Since then, CMCC has met monthly (or, at times, every other month). Its purposes are to share experiences and information primarily related to digital data development, and to provide a forum for education about GIS. During this time CSMAC continued to operate, but that agency decided to not become involved in automated mapping.

In 1987 the Teale Data Center, organized under the Secretary of Business, Transportation and Housing, and with the Department of Health Services (DHS), began a pilot study to investigate the use of GIS for managing toxics in California. With help from various GIS hardware and software vendors, several geographic data sets were constructed and linked with existing databases at DHS. A demonstration of the results of this pilot project were presented in the spring of 1988. Based on the success of the project, Teale began formally offering GIS services in late 1988.

Coordination Efforts, Groups and Activities

Since 1989, GIS coordination activities in California have been led by the Teale Data Center.

The Office of Information Technology (OIT), in the Department of Finance, is responsible for statewide information technology planning and policy, but has not yet assumed a role regarding GIS coordination.

Teale's GIS Laboratory was established to provide technical and other assistance to state agencies using or desiring to use GIS. Additionally, Teale has promoted coordination and development of a state spatial database and geographic data library that is maintained on-line (see **GIS in State Government**). The GIS library is accessible over an ethernet network. Teale is encouraging the development of common or "standardized" geographic data layers that could be shared among several agencies. Data is maintained in the library by county tile structure.

Coordination Groups

California currently has four informal groups influencing and coordinating geographic information and GIS in the state. The Computer Mapping Coordinating Committee (CMCC), organized in 1986, is an advisory group comprised of representatives from various state agencies, departments, commissions, and boards, and from the University of California. It also includes some federal, regional and local agencies, with a total of over 100 persons on its mailing list. CMCC was originally initiated by the Resources Agency, and is currently chaired by the GIS Manager at the Teale Data Center. CMCC meets every other month.

According to their June 1989 charter, CMCC functions as a users group and as a forum for the development of policy statements and guidelines regarding the use of GIS and other related data, and it also assists in the development of standards and specifications for the capture of spatial data. Topics of concern include the acquisition, creation, storage and indexing of spatial data sets, system networking, and program coordination. CMCC's objectives include acting as a clearinghouse for information about spatial data sets, as well as developing a Spatial Data Index.

CMCC provides a collective focus for state GIS activities and expertise to aid in resolving shared problems, interagency project development and coordination, dissemination of information, and mutual support. It also provides a forum for coordinating among all levels of government in the state, and provides a link to non-governmental organizations in the private sector and academic community. Participants provide guidance and assistance for each other. Recent focus has been on remote sensing, standards and county activities.

CMCC has established two subcommittees, including one which addresses standards, and the other which is involved with remote sensing. The Standards Subcommittee is working to suggest

standards to facilitate the sharing and use of digital data. The Remote Sensing Subcommittee is coordinating acquisition of satellite imagery. Both groups are developing mechanisms for sharing data. The Teale Data Center supports a GIS User Group that was established in 1990 for agencies interested in using Teale's GIS services. It meets every other month and provides input on GIS services and common requirements for data among agencies. Its activities include developing a method to document data and evaluating methods of digitizing data. The group also compares hardware and software that may be used for GIS activities.

The California State Mapping Advisory Committee (CSMAC) is a group which does not meet often. Until recently, it did not address GIS, although in 1990 it began to refocus its attention and now includes digital data activity. CSMAC participation includes 19 state agencies.

The California Department of Forestry's Forest and Rangeland Resources Assessment Program began in 1978 with the development of a statewide vegetation classification using LANDSAT imagery to support monitoring land use changes, biodiversity analysis, and image interpretation and simulation models.

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According to the 1956 legislation which established the California Department of Water Resources (DWR), this agency is directed to "collect information relative to maps and surveys of the State of California or parts thereof and provide a public information service for public and private persons and agencies relative to maps and surveys of the State." DWR chairs CSMAC, as called for by this legislation, and it officially provides input to the U.S. Geological Survey (USGS) regarding mapping priorities. It also provides information regarding the state's Geographic Names Information System in coordination with the USGS, and has worked with recent adjustments to the North American Horizontal Datum.

In addition to these state groups, a variety of regional groups have evolved in their efforts at GIS coordination, and public sector employees also participate in vendor-based user groups. The Southern California Computer Aided Mapping Association (SCCAMA) was one of the first regional GIS coordinating groups in the country.

Efforts were underway during the 1990 and 1991 legislative sessions to create a Geographic

Information Task Force. A bill introduced during the 1990 session passed the legislature but was vetoed by the governor. The bill was passed by the legislature in the 1991 session, and was signed by the governor. The task force will address geographic data development and use, property management, planning, risk assessments, and environmental decision making at all levels of government and the private sector. The task force will include 16 other members representing state agencies, counties, cities, federal agencies, the California Land Surveyors Association and the California Council of Civil Engineers and Land Surveyors. It is expected the task force will be a high level policy group.

The bill provides that a report be submitted to the legislature which would include recommendations for organizational and institutional structure, roles and responsibilities of agencies and the private sector, procedures for ensuring data quality and sharing, mechanisms for institutionalizing, and funding for the development of geographic information.

GIS in State Government

The Department of Finance includes the **Office of Information Technology** (OIT), created by 1983 legislation, which is responsible for setting statewide information technology policies and procedures. The legislation also requires each state agency to submit an Information Management Annual Plan, and OIT is authorized to approve agency information technology activities. OIT has not participated in GIS activities.

The Department of Finance also includes the **State Census Data Center**. Teale processed pre-Census TIGER files available from the U.S. Census Bureau for the State Census Center. It is using Atlas-GIS for demographic analysis. Discussions are underway with local governments in an attempt to improve the completeness and accuracy of the TIGER files.

Responsibilities of the Secretary of Business, Transportation and Housing includes the **Teale Data Center**, which is the largest multi-purpose computing data center in state government. The Executive Branch is served by two large mainframe computing centers which provide services to other agencies. The other large computing center is located at the California Health and Welfare's Agency Data Center (see below). Teale provides computing services and facilities to over 200 state agencies.

Teale's GIS Laboratory, established in 1988, was created to provide technical help and other assistance to state agencies using or desiring to use GIS. The data center's functions include establishing a service bureau, developing and maintaining a geographic digital data library, and fostering related interagency coordination. GIS services are provided in a laboratory environment on a cost recovery basis similar to other computing services available at Teale. Services are provided primarily for state agencies, but some services are provided for federal and local agencies, as well as for the private sector.

The laboratory provides access to GIS hardware and software and offers expertise to agencies using the technology. Agencies are assisted with their existing data files and are introduced to additional relevant files maintained at Teale. Services include consulting, needs assessments, GIS data development, and pilot studies assistance. Data entry services including digitizing and the development of linkages between agency databases and existing or needed "mapped" data layers. The laboratory also provides address matching, data maintenance, customized user interfaces, image processing, and specialized processing, and an electrostatic plotter is available to all clients. The Center offers also offers training and education. An overview of Teale's GIS facilities, services and data is provided in the April, 1990 document entitled *Teale Data Center GIS: Providing Data Integration, Management and Analysis.*

The GIS Laboratory has an annual budget of approximately $700,000, and operates on a cost recovery basis. There are six professionals and three students on the staff that provides GIS services.

Teale currently supports GIS technology in a UNIX environment running ARC/INFO on a SUN file Server and using SUN and DEC workstations.

One of Teale's main efforts is the development and management of a geographic data library that is maintained on-line. The GIS library is accessible over an ethernet network. Teale is encouraging the development of common or "standardized" geographic data layers that can be shared among several agencies. Some state agencies are accessing data via a TCIP network, such as the State Lands Commission, the Department of Transportation, and CDF.

Data development activities are underway at Teale in cooperation with other agencies, and most data is maintained at the 1:100,000 scale. Data layers available include county boundaries, senate/assembly districts, air basins, geology, wells, toxic waste sites, watersheds, hydrography, roads, major highways, vegetation, and census tracts/blocks. Other data are under development. Currently there are approximately 20 agencies which contract work with Teale's GIS laboratory.

The **California Department of Conservation** (CDC) tracks farmland conversion and urbanization in the state. CDC established the Farmland Mapping and Monitoring Program (FMMP) in the late 1970s to provide data on the nature, location and extent of farmland, grazing land, and urban buildup areas. This effort was reinforced by legislation adopted in 1981 which established a non-regulatory program to provide information, maps and conversion statistics to the legislature and counties. Funding for FMMP is obtained from property owners who sign agreements under the Williamson Act, which allows property owners who maintain land for agricultural purposes lower property tax appraisals. If property owners change the status of their lands within a ten-year period they are then required to repay the tax rebate, and this creates funds for the FMMP program.

Initially, data was compiled from the U.S. Department of Agriculture's Land Inventory and Monitoring (LIM) system (initiated in 1975) and from soil survey maps developed at the 1:100,000 scale by the U.S. Soil Conservation Service (SCS) for 37 California counties. Information is currently maintained at the 1:100,000 scale, and CDC is co-funding soil surveys with SCS. Updated maps and statistical information are presented in the Farmland Conversion Report, published bi-annually.

In addition to tracking and providing information on farmland conversion, applications include providing assistance for establishing prime farmland agriculture preserves, toxic waste dump siting, locating prisons (in relation to both agricultural and urban land sites), and identifying routing alternatives for electrical transmission corridors. The system also provides information for the 1990 California Desert Protection Act. This act proposes that 14,000 square miles of federal lands be set aside, and further establishes over 80 new wilderness areas. During this process, information from FMMP was compared with similar data from the Federal Bureau of Land Management. FMMP also supports the Division of Recycling by mapping supermarkets and recycling centers and zones.

CDC's annual operating expenses for FMMP totals $585,000, and five staff members conduct its work (with additional help from students). Since a system upgrade in 1987, the program is using Intergraph and SPANS software on a MicroVAX computer.

The **Board of Forestry**, created in 1985, determines the state's forest policy and oversees the provision of wildland forest protection services on all forests and rangelands maintained by the state. Since its formation, the California Legislature has increased the board's responsibilities to include policy oversight on the licensing of professional foresters, and forest practice regulation that includes timber harvesting on private and state lands, wildland research, hardwood land management and use, reforestation, resource assessment, urban forestry, and related public education. The **California Department of Forestry** (CDF) is responsible for carrying out these roles, with 90% of its budget used for firefighting purposes.

CDF's Forest and Rangeland Resources Assessment Program (FRRAP) uses GIS for a variety of programs and purposes. Its efforts began in 1978 with the development of a statewide vegetation classification using LANDSAT imagery to support monitoring land use changes, biodiversity analysis, and image interpretation and simulation models. These efforts evolved to GIS involvement in the program, and resulted in the purchase of commercial GIS software in 1986 (see **Origins of State Initiatives**).

FRRAP has three full-time staff positions allocated for GIS work, including a Research Program Specialist. Three students support the staff's efforts. GIS expenditures are approximately $3.5 million, including personnel expenses, hardware and software purchase and maintenance (approximately $200,000), and data development, some of which is under contract with the Teale Data Center. Funds for data development are partially obtained through the Environmental License Plate Fund and from cigarette taxes. FRRAP uses two DEC workstations and personal computers with ARC/INFO software.

FRRAP's databases include over 25 data layers, including natural resource information obtained from various sources (at various scales), some of which is available statewide. FRRAP is moving toward storing all data layers at the Teale Data Center, enabling access of the natural resource and other data through a network managed by Teale. FRRAP has contracted with Teale for conversion of Department of Conservation Farmland Mapping Program land use data from an Intergraph SIF format to ARC/INFO. This data will be used to examine the distribution of grazing lands in the state. DLG data for hydrography, transportation, and watershed boundaries and the Public Land Survey System data (1:100,000 scale) is now being acquired from Teale.

FRRAP helped fund the development of the hydrography data layer, and is providing funding for a student to edit the Public Land Survey System information maintained by Teale's data library. FRRAP has also obtained data from federal agencies and private companies. One of FRRAP's main data development efforts is to update the state's vegetation data layer, in accordance with the mission of the Timberland Task Force (see below).

FRRAP's other major effort involves developing the state ownership layer. Bureau of Land Management Surface Management Status maps at the 1:100,000 scale were updated for each national forest and for county maps and Department of Parks and Recreation state park maps. Digital data from individual national forests has been received, and efforts have been made to input the information into this data layer, although some technical difficulties have been experienced. The U.S. Forest Service is moving its remote sensing inventory program from San Francisco to Sacramento so that it may be collocated with FRRAP. It is expected that this change of venue will augment the heterogeneity of this data and improve its shareability. In addition, other ownership maps are being used to update the data layer. CDF was the creator of the public land data layer which is now being updated by Teale.

Contracts now being discussed with Teale involve the process of digital elevation model data statewide and digitizing historic vegetation maps in order to learn changes over time. In addition to these efforts, 1:24,000 scale maps are being used for firefighting purposes, and Teale is developing fire protection responsibility maps. A land use study in the central Sierras is being considered that would be based partially on assessor records. Consideration is being given to implement GIS at ranger units for fire protection and timber harvest plan review. Pilot projects are underway in this regard for some ranger units.

Applications

FRRAP has a variety of GIS applications underway or planned, including the following:

Biodiversity: Areas of diverse species richness in the Valley Foothill Hardwood type have been identified as part of a pilot effort in biodiversity analysis. This effort includes identification of critical hardwood stands and will be applied to other vegetation types and ecological regions. Other biodiversity work is being conducted with the U.S. Bureau of Land Management.

Central Sierra Land Use Change Model: FRRAP is cooperating with the U.S. Forest Service's Pacific Southwest Experiment Station to project future settlement patterns for Central Sierran counties. Impacts of settlement on biodiversity, economic development, water, fire, forest health, resource-based industry viability, and other resource values are being analyzed.

Forest Inventory: FRRAP is cooperating with the Forest Service's Pacific Northwest Station Forest Inventory and Analysis (FIA) unit to explore possible improvements in forest inventory procedures by using GIS and related data.

Timber Supply Modeling: FRRAP's GIS is used to support the timber resource and project timber inventory, harvest, growth, and resulting wildlife habitat for a variety of future scenarios. FIA forest survey data is combined with FRRAP data layers for describing initial inventory conditions by land use class for input into FRRAP's CALPLAN model.

Rangeland Issues: The extent and nature of hardwood rangeland overstory, blue oak regeneration and sample frames for hardwood vegetation dynamics are being developed using GIS. In addition, an institutional framework for the control of non-point source pollution from rangeland is being used to determine the numbers and identities of Resource Conservation Districts that will be charged with ensuring water quality.

Urban/Agricultural Conversion Modeling: FRRAP is working to compile historical vegetation data for comparison with current USGS land use and land cover data. By comparing this data, projections can be made about future conversions of forest and rangeland vegetation to urban and agricultural uses.

A major FRRAP effort is the support of the Timberland Task Force, whose work is expected to result in a comprehensive, statewide land cover map that will help develop a digital vegetation layer for use with GIS.

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Cumulative Effects: FRRAP is supporting research and development projects in cooperation with local landowners that address the assessment and mitigation of cumulative effects. Two watersheds are being used as pilot projects to test different methods of assessing these impacts. GIS will assist in summarizing conditions, displaying impacts and evaluating mitigation alternatives.

Improving Water Yields: FRRAP will be used to link vegetation, hydrology and land use data for determination of current and future water yield spatial patterns on forest and rangelands. Modeling techniques will be used to analyze the impact of water marketing strategies and changing management practices.

Habitat Conservation Planning: FRRAP is investigating how mixed ownership patterns affect conservation planning for the Northern Spotted Owl. Owl activity centers also will be analyzed using GIS in conjunction with current harvest activities.

Statewide Natural Resources Assessment: These assessments are conducted every five years to support resources sustainability in the state. GIS helps

in development and production of these analyses.

In addition to these projects, a major FRRAP effort is the support of the **Timberland Task Force**, whose work is expected to result in a comprehensive, statewide land cover map that will help develop a digital vegetation layer for use with GIS. The Timberland Task Force, created by 1989 legislation, is working to design a system which would improve wildlife protection, protect biodiversity, assist in habitat conservation plans, and ensure forest land productivity. The task force is also charged with laying out a strategy to better anticipate and avoid the negative environmental effects of timber harvesting and other operations, and to provide judgement about risks and costs of alternative levels of protection. Assembly Bill 1580 directed the Timberland Task Force to conduct the following four activities:

• Develop a coordinated base of scientific information on the location, extent, and species composition of timberland ecosystems in California. This information is to include an accommodation of a range of definitions of timberland habitats, an evaluation of the cumulative impacts of timber harvesting and other activities on the biodiversity of timberland ecosystems and on individual species, an evaluation of timberland habitat concerning its contribution to the overall maintenance of specific wildlife species, and an estimation of the economic impacts of alternative mitigation measures.

• Design and contract for studies to validate wildlife habitat models and management prescriptions for species using timberland habitats; evaluate the effectiveness of alternative mitigation measures to minimize the environmental effects of timber harvesting; and develop programs designed to maintain or develop the physical characteristics of wildlife habitats.

• Identify critical habitat areas necessary to maintain and restore viable populations of species dependent upon specific timberland habitats for all or part of their life cycle, beginning on the north coast.

GIS is considered a key tool for these objectives, and development of digital land cover data is considered essential to meet them. FRRAP has historically taken the lead in the state to develop the vegetation layer (similar to the land ownership layer). Development of this data was initially performed by FRRAP using 1977 LANDSAT MSS data.

A pilot project was initiated as part of the task force's work in the Sierra's Klamath Province region in the Sierras. Vegetation mapping will be completed by December, 1991 for a 6 million-acre, mixed ownership area using 1990 LANDSAT data, and will then be expanded to the entire region.

The imagery will be used to classify and analyze vegetation types related to wildlife habitat. This effort is a pilot project which will demonstrate the capability to classify forest lands vegetation for the entire state. The task force was directed to conduct initial work in the northern part of the state, and because of the Northern Spotted Owl controversy, the Klamath Province area was selected. An advisory task force was convened that included federal and state agency representatives in order to help develop and assess a vegetation classification scheme.

The task force's work is being coordinated with the California Interagency Wildlife Task Group and its California Wildlife Habitat Relationships Program in order to help develop a long-term wildlife protection strategy. The program has been underway since 1981 and has resulted in a comprehensive system consisting of a wildlife species list and associated information, species distribution maps, automated databases of species-habitat relationships models, and habitat classification and vegetation descriptions.

CDF's **Fire Protection Section** conducts fire protection planning. It has three staff workers using Atlas-GIS on personal computers to produce a fire simulator model which enables the staff to model equipment and risk with differing fire scenarios. The system is also used to conduct fire prevention planning, particularly in relationship to urban interfaces.

The **Department of Fish and Game**'s Natural Heritage program and Natural Diversity Database are both using GIS, and consideration is being given to conduct a department-wide GIS needs assessment. The program provides data for planning purposes concerning the location and condition of rare and endangered native species and natural communities. Data being developed at the 1:24,000 scale include species and community inventory, managed area inventory, and significant natural areas. The program is conducted in cooperation with The Nature Conservancy which is subsidizing the program's efforts with GIS services and with partial funding. The department is using Genamap and Oracle software on a Hewlett Packard workstation. In addition, the legislature gave the department some responsibility for oil spill mitigation. Efforts are underway to consider use of GIS to help meet this need.

The **Department of Parks and Recreation** is using GIS for the administration of California's off-highway vehicle parks and is considering agency-wide GIS needs for future efforts. This work is partially conducted under contract with San Diego State University, and the University of California at Berkeley and at Riverside.

The **Department of Water Resources** (DWR) has a variety of water resource and mapping responsibilities in California. It was directed by the legislature to "collect information relative to maps and surveys of the State of California or parts thereof and provide a public information service for public and private persons and agencies relative to maps and surveys of the State." DWR's Map Information office was designed to meet this need. DWR's Division of Land and Right of Way includes a 46-member professional staff with a $5 million state-funded budget. It prepares maps and legal descriptions that are incorporated within DWR's Land information System. Aerial topographic surveys are also conducted for DWR engineering projects. DWR uses CAD, digital terrain modeling software and GPS.

DWR's Division of Planning has been using GRASS since 1988 on SUN workstations. It is developing watershed boundaries at the 1:24,000 scale and shares data with the Federal Bureau of Reclamation. The division has a two-person staff with an annual budget of approximately $160,000, most of which is obtained through fees. The Division of Planning's Computer Services Division uses Intergraph software.

The **Coastal Commission** is currently using Auto-CAD for resource mapping purposes. A pilot project was conducted to explore use of GIS. It has been working with the State Land Commission and Teale Data Center on thematic mapping, resource management, and monitoring applications. It is developing 1:24,000 scale data for on-and off-shore coastal resources, jurisdictional boundaries, and land use zoning. Discussions are underway to share data with the National Oceanic and Atmospheric Administration. Some exchange of digital data is occurring within local governments.

The **California Environmental Affairs Agency** includes the Air Resources Board, the Water Resources Control Board, and the Waste Management Board. Since the mid-1980s the **Air Resources Board** has been using raster software developed in-house. The purchase of commercial software for GIS applications is under consideration.

The **Water Resources Control Board** has contracted with Teale to conduct a comprehensive needs analysis for agency-wide GIS services, and a draft feasibility statement is also planned. The board began implementing ARC/INFO software on four SUN workstations in 1990. These workstations are being used to develop data and to conduct analyses in the San Gabriel Basin under a cooperative agreement with the U.S. Environmental Protection Agency (EPA), which will also provide funding. Three of the four stations are located in the board's Los Angeles office. GIS is also being used to track Superfund sites and investiga-

tions. The board has an additional contract with Teale to evaluate wells using U.S. EPA's STORET data.

The **State Lands Commission** administers land ceded to California at statehood and includes approximately 610,000 acres. It has a GIS Working Group developing a comprehensive review of potential applications of GIS. It is investigating GIS use for land record administration, environmental impact evaluation and oil spill mitigation and monitoring as part of the Commission's Coastal Resources Information Data Base. The commission has three DEC workstations using ARC/INFO software.

The **Health and Welfare Agency** includes all social services department functions, including employment and health programs. Its Health and Welfare Data Center is the second largest data center in state government (after the Teale Data Center). Since 1990 the center has had a full-time staff person allocated for GIS work, and it has canvassed the agency's departments regarding GIS. It is running ARC/INFO software on its UNISYS mainframe and also has a workstation for this purpose. The center has a pilot project underway with the Department of Health Services to test the value of GIS as an analysis tool for managing and assisting the operations of mediCal, California's version of medicare.

The **Department of Health Services** has ARC/INFO software on a Tektronix workstation in Berkeley. The system is being used to support epidemiological studies, and will later be used for mapping cancer rates, including those that occur near toxic waste sites. The Toxic Substances Control Division has provided addresses of the major toxic waste generators in the state to the Teale Data Center's GIS Laboratory. The Water Supply Branch provided the location of public drinking supply wells to Teale. Both data sets are shared with other agencies.

The **Department of Food and Agriculture**'s Computer Services Division is using Dynamic Graphics three-dimensional modeling software on a PRIME minicomputer to monitor pesticide use, pest infestations, and groundwater impacts. The department is working with Teale's GIS laboratory to evaluate the demographics of aerial spraying areas to determine the appropriate language for public notification of pesticides applications. The department is also using GIS to help consider critical wildlife habitat potentially effected by pesticides.

The Department of General Services' **Office of Real Estate and Design Services** (OREDS) is required by California Assembly Bill 3932 to create and maintain a statewide real property inventory of state real property held by the state. One com-

ponent of this inventory involves mapping the location of state-managed lands and buildings. OREDS is using Teale's 1:100,000 base scale data. OREDS is funding Teale's development of the digital version of the 1:100,000 scale Public Land Survey System (PLSS) boundaries. Parcel codes are being identified for each state asset. Since late 1988, OREDS has used ARC/INFO on a PRIME 9955. In addition to Teale's staff conducting this work on contract, OREDS has two staff members working with GIS.

The **Board of Equalization** is conducting a study of the feasibility of implementing GIS to consolidate the board's two existing manual geographic information processes. The board is required by statute to map the boundaries of all local jurisdictions that have an ad valorem property tax. Local agencies must file maps of all jurisdictional boundary changes with the board. These changes are presently consolidated on county maps and are coded to identify the combination of jurisdictions that can levy taxes within a given geographic area. This information is provided to county officials for preparing assessment rolls. The board also allocates local government's share of the state sales tax based on the updated jurisdictional boundaries that are developed as part of the property tax process. These processes are currently manual and the study is evaluating the feasibility of automating them, and of creating and providing a large scale digital map base of California. The study is being conducted with local assessors.

The **Office of Emergency Services** (OES) is California's emergency management agency. OES has a designated GIS coordinator and has used GIS to support earthquake preparedness, including studying simulated responses to disasters such the 1989 San Francisco earthquake. Following the disaster, McDonnell Douglas GDS software was donated to OES which operates on a DEC VAX minicomputer with ORACLE software. The Federal Emergency Management Agency (FEMA) is donating its IEMIS software and data to OES, and efforts are also underway to acquire digital orthophotoquads at the 1:12,000 scale from the U.S. Geological Survey. OES is using data already developed for the state at the 1:100,000 scale, and is developing additional data at this scale concerning pipelines, hazard and risk zones, and fire history.

GIS applications are also underway with some of the state's local and regional entities. For example, OES is working with Santa Barbara County on a mitigation analysis for the Painted Cave fire area, with San Luis Obispo County on the Mt. Diablo Nuclear Power plant pilot project, and with San Francisco and Los Angeles regional entities for earthquake preparedness.

The California **Department of Transportation** (CALTRANS) uses a variety of GIS software for various purposes, primarily for CAD applications. These packages include ARC/INFO, Synercom, Intergraph, Informap, and Ultimap for CAD, computer mapping, and analysis and planning applications. The department has a task force which is considering GIS, and it also works with the Teale Data Center, particularly to develop 1:100,000 scale digital data for roads based on DLGs from USGS. Milepost markers have been registered within the 1:100,000 scale base, and all divisions of the department use the same referencing scheme. Digitizing efforts are also underway for the transportation layer at the 1:24,000 scale using the Synercom system, but this project is currently only approximately 10% complete. Manual maps are produced at the 1:10,000 scale.

A department-wide Long Range Plan is being developed for GIS use across CALTRANS using the 1:100,000 base map. ARC/INFO and Ultimap software are being used for GIS applications, which include capital improvement planning, systems planning, and transportation planning modeling, each in a different CALTRANS division. A pilot project was conducted for bridge prioritization for earthquake retrofits, and the Federal Highway Administration approved a grant to CALTRANS to develop pavement management system applications using GIS.

Academic Activities

California has many public and private institutions with GIS activities and facilities. For example, **California State University** (CSU) at Sacramento has a Multidisciplinary GIS Center, which includes part-time faculty and staff who work on GIS education and research. The center sponsored a GIS workshop for CSU faculty and has ARC/INFO, ERDAS, Mapmaker and related software that was originally funded through a grant from the university. CSU's Department of Geography is beginning to offer GIS education in its classes.

The **University of California** (UC) at Berkeley was an early innovator in GIS, including work conducted with the Department of Forestry and Fire Protection (CDF). More recently, UC-Berkeley and other state supported universities have been conducting contract work with state agencies and others. Frequently, students work on GIS as interns at state agencies. UC-Santa Barbara is one of three sites of the National Center for Geographic Information and Analysis (NCGIA). It is providing guidance and assistance to CALTRANS in the development of its Long Range Development Plan. NCGIA has provided assistance to CDF, including a research project that evaluates use of spatial data and GIS for conifer lands. It may be involved in an accuracy assessment project

in cooperation with the Timberland Task Force. UC-Davis has an extension program with GIS classes.

Documents List

Teale Data Center GIS: providing Data Integration, Management and Analysis, (State of California) Teale Data Center, April, 1990.

This document reviews GIS facilities, services and data at the Teale Data Center, California state government's computing facilities and services entity. It describes the GIS Lab and Teale's GIS User Group. Services described include consulting, training and education, digitizing, database development, database linkages, customized user interfaces, specialized processing, plotting, and hardware and software procurement assistance. The booklet also includes a review of Teale's online library of geographic data. The GIS library is accessible through an ethernet network. Data is maintained in the library by quadrangles defined by latitude and longitude, and by county. Descriptions and maps indicating coverages available on the library are included in the document. Data layers available include county boundaries, senate/ assembly districts, air basins, geology, wells, toxic

waste sites, watersheds, hydrography, roads, major highways, vegetation, public land ownership, public land ownership, public land survey, and census tracts/blocks. Additional data layers are planned.

California Planning Agency Experiences with Automated Mapping and GIS, French, Steven P., and Lyna L. Wiggins, Presented to the International Conference on Computers in Urban Planning and Urban Management, August 22-25, 1989, Hong Kong, Revised March 23, 1990.

This paper reviews a March 1989 mail survey conducted within city and county planning agencies in California. The survey identified a large number of minicomputer systems and stand-alone microcomputers which are used by these agencies for mapping purposes. A majority of these systems are involved with GIS, and most of the thematic mapping packages are in agencies with larger systems. The paper reviews the major software packages being used in California planning agencies, and attempts to show how hardware and software configurations are changing over time. Land parcel mapping and traditional planning tasks related to the general plan appear to be the most important urban planning applications of these existing systems. Implementation and development problems are discussed, including technological and institutional issues.

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